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(54) **IMAGE FORMING APPARATUS**

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CPC ***G03G 15/5054*** (2013.01); ***G03G 15/5058*** (2013.01)

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CPC G03G 15/5062; G03G 15/5058; G03G 15/5054
USPC 399/44, 49, 51, 301, 297
See application file for complete search history.

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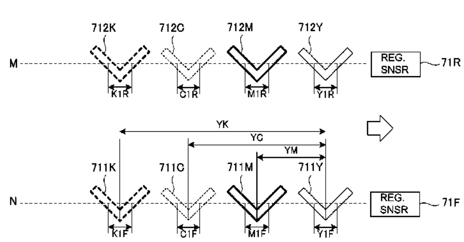
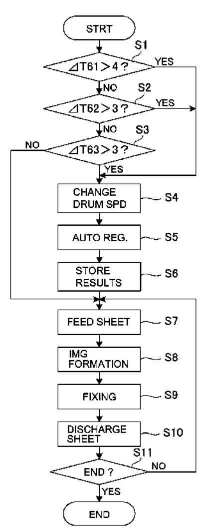
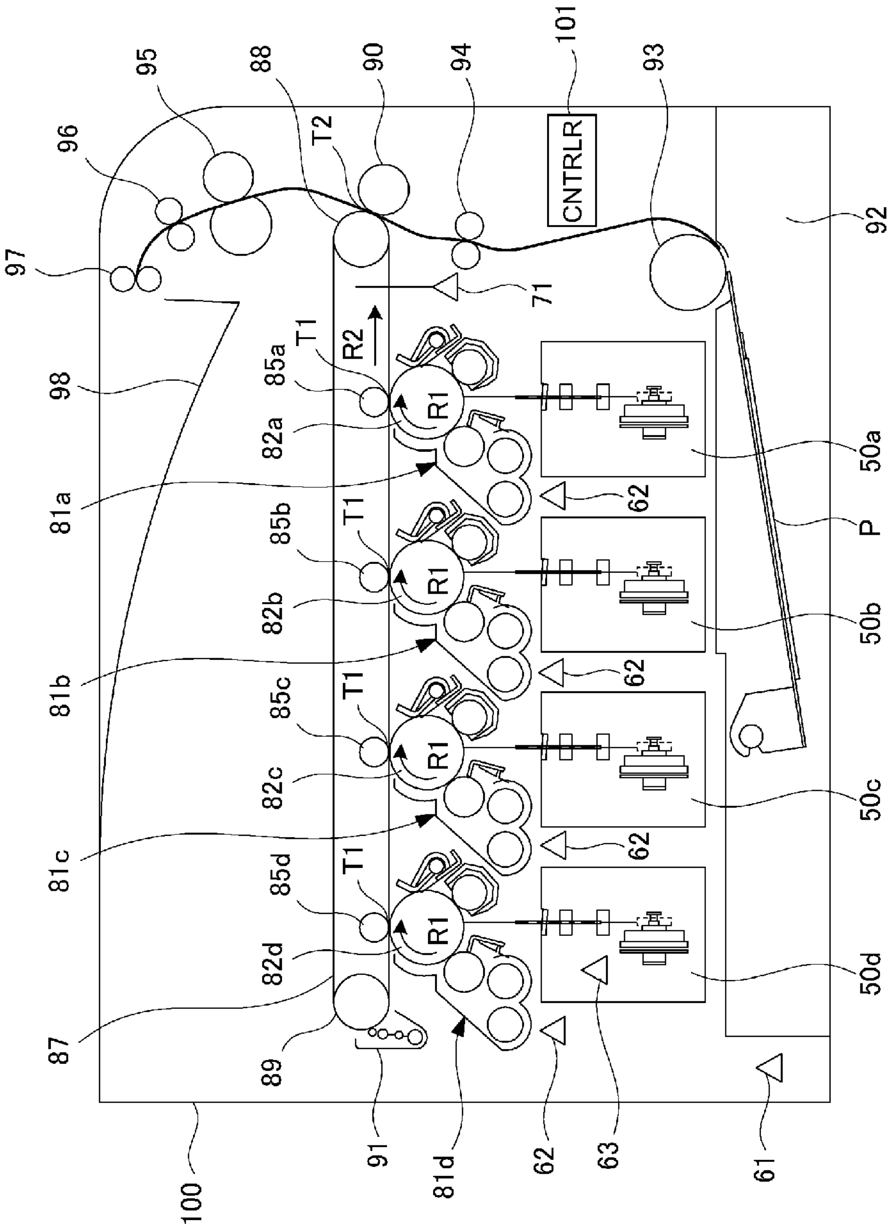
(57) **ABSTRACT**

An image forming apparatus includes a determiner for determining whether to execute a first image formation in an acquisition mode, in which an image forming operation is carried out using an acquired timing, or a second image formation in a non-acquisition mode, in which the image forming operation is carried out using exposure timing acquired in a previous acquisition mode. The determiner makes the determination on the basis of a current output of a temperature sensor and a previous output of the temperature sensor. When the determiner determines the execution of the first image formation, driving speeds of a first driver and a second driver are set, before the execution of the operation in the acquisition mode, on the basis of the current output of the temperature sensor, and the operation in the acquisition mode and the image formation are carried out using the driving speeds currently set.

10 Claims, 5 Drawing Sheets

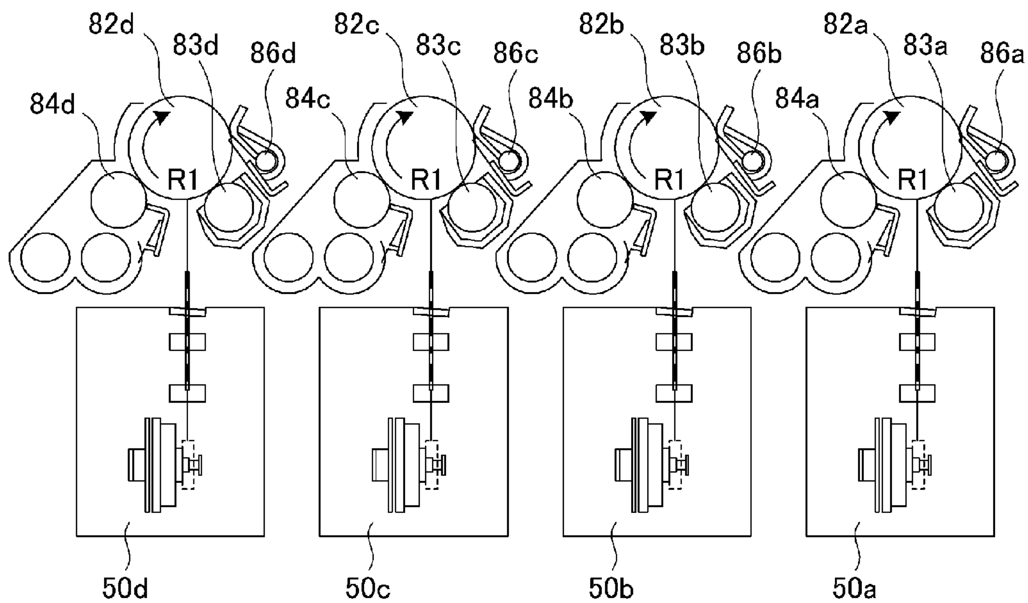






95
88
90
94
101
93
96
T2
CNTRLR
97
92
71
T1
R2
85a
98
82a
R1
50a
81a
62
85b
P
82b
50b
81b
85c
82c
50c
81c
85d
82d
50d
87
89
91
81d
63
61
100

Fig. 1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83d
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R1
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50c
50b
50a

Fig. 2

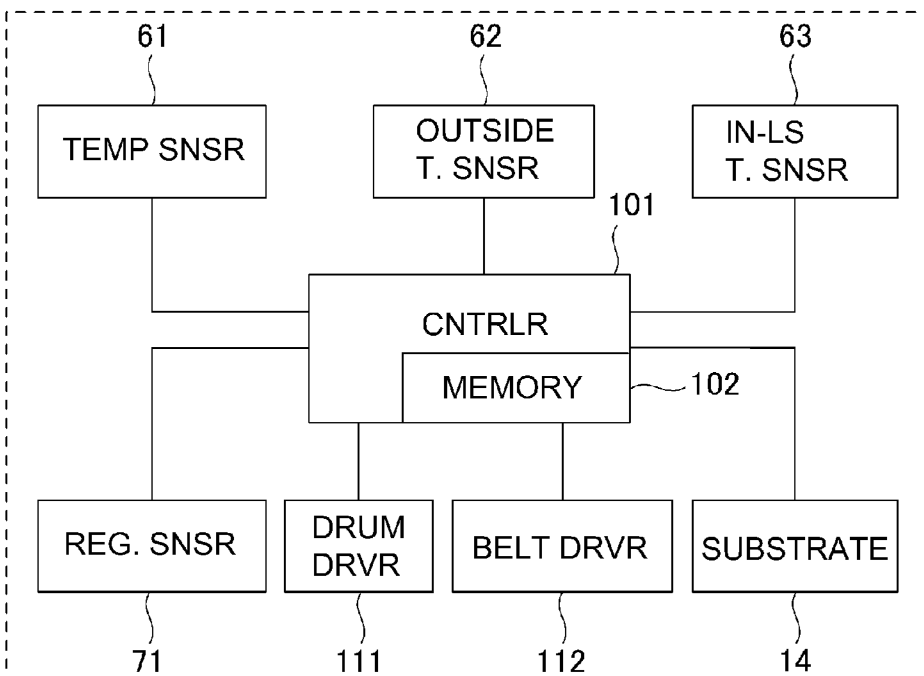
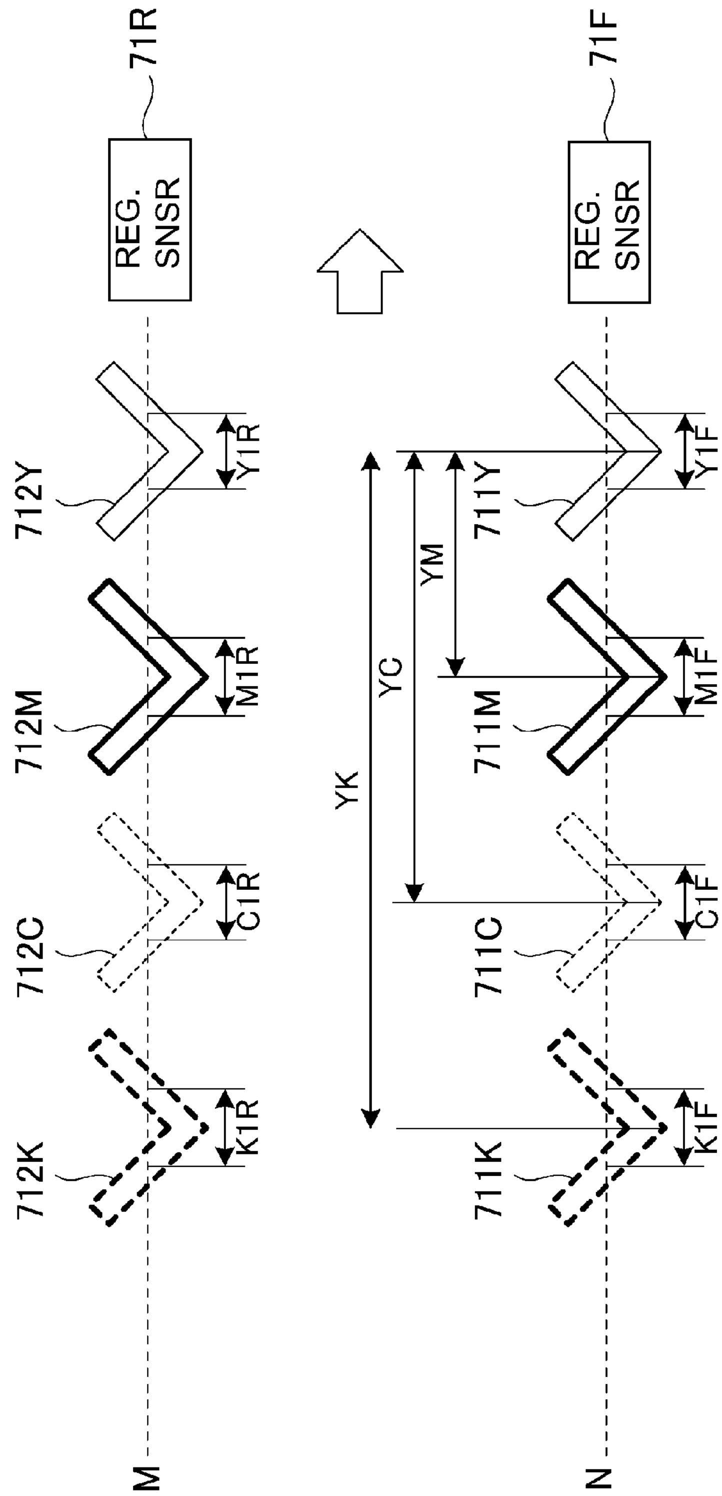

61
62
63
TEMP SNSR
OUTSIDE
T. SNSR
IN-LS
T. SNSR
101
CNTRLR
MEMORY
102
REG. SNSR
DRUM
DRVR
BELT DRVR
SUBSTRATE
71
111
112
14

Fig. 3



71R
REG. SNSR
71F
REG. SNSR
712Y
712M
712C
712K
711Y
711M
711C
711K
Y1R
M1R
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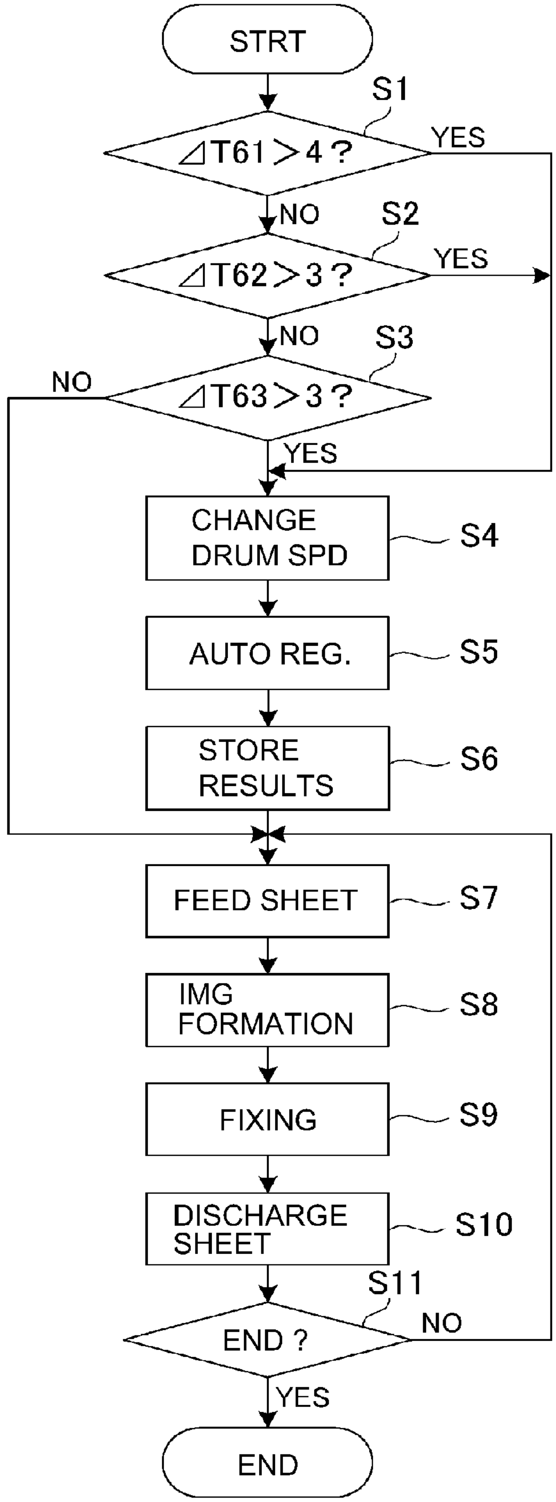
K1R
Y1F
M1F
C1F
K1F
YK
YC
YM
M
N

Fig. 4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S2
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YES
NO
S3
NO
⊿T63＞3？
YES
CHANGE DRUM SPD
S4
AUTO REG.
S5
STORE RESULTS
S6
FEED SHEET
S7
IMG FORMATION
S8
FIXING
S9
DISCHARGE SHEET
S10
S11
END ?
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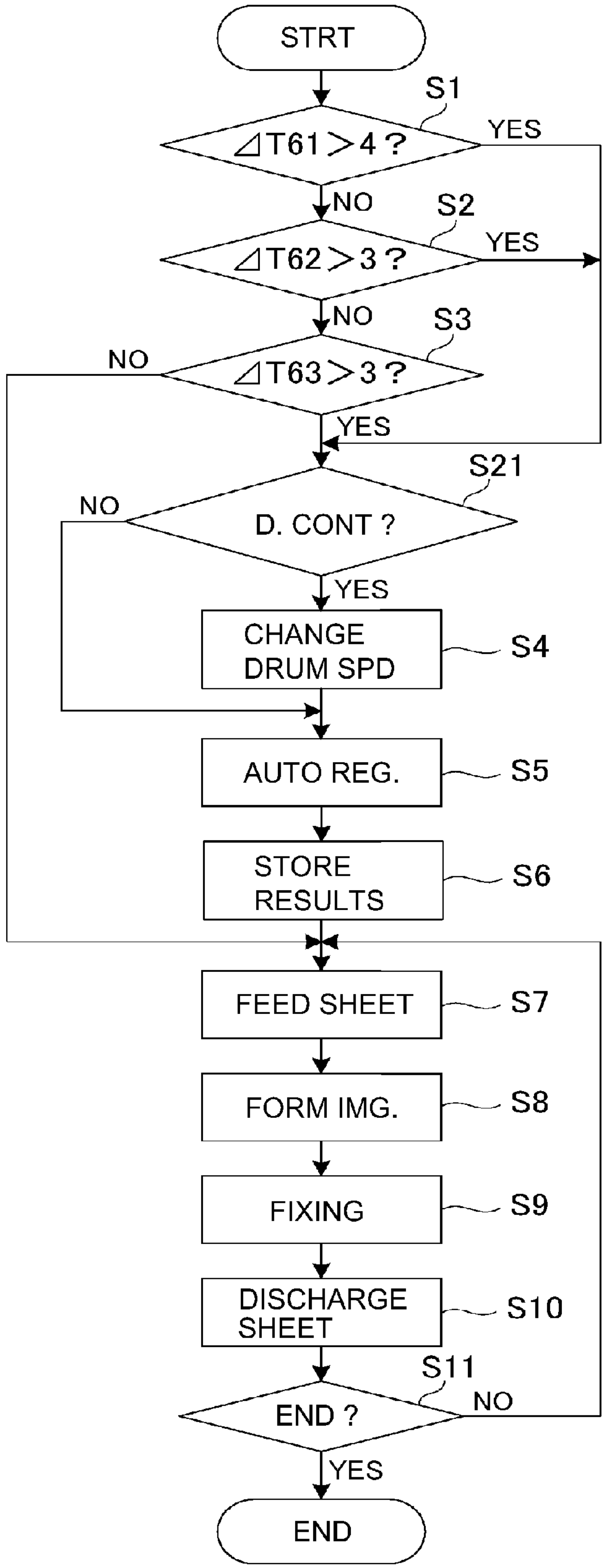
END

Fig. 5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NO
S2
⊿T62>3 ?
YES
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S3
NO
⊿T63>3 ?
YES
S21
NO
D. CONT ?
YES
CHANGE DRUM SPD
S4
AUTO REG.
S5
STORE RESULTS
S6
FEED SHEET
S7
FORM IMG.
S8
FIXING
S9
DISCHARGE SHEET
S10
S11
NO
END ?
YES
END

Fig. 6

IMAGE FORMING APPARATUS

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to an image forming apparatus using electrophotographic technique, such a printer, a copying machine, a facsimile machine or a multifunction machine. More particularly, it relates to the image forming apparatus in which a multi-color toner image formed by overlaying different color images is transferred all together.

Recently, various image forming apparatuses in which images are formed using endless belt members have been used. In an example of such image forming apparatuses, an intermediary transfer belt is used for image formation (intermediary transfer type), or a recording material feeding belt is used for image formation (recording material feeding type). In the case of the intermediary transfer type image forming apparatus, different color toner images are transferred superimposedly on the surface of the intermediary transfer belt, so that a multi-color (full-color) toner image is formed, and the formed multi-color toner image is transferred altogether onto a recording material from the intermediary transfer belt. The intermediary transfer belt and the photosensitive drum can be controlled respectively such that they are rotated at the same peripheral speeds or with a slight peripheral speed difference.

The intermediary transfer belt is extended around a plurality of rollers, and is rotated by one of the rollers which is a driving roller. The driving roller is provided on the outer periphery thereof with an anti-slip rubber, which expands with increase of the temperature. In such a case, an outer diameter of the driving roller increases. Then, the rotational speed of the intermediary transfer belt increases with the result that the above-described relationship of the speeds of the surfaces of the intermediary transfer belt and the photosensitive drum is not maintained, and this leads to color misregistration when the respective color images are transferred onto the intermediary transfer belt from the photosensitive drums. Japanese Laid-open Patent Application 2006-53448 proposes an image forming apparatus in which the rotational speed of the photosensitive drum or the intermediary belt is changed on the basis of the temperature in the main assembly of the image forming apparatus, during the non-image-formation period so as to correct the peripheral speed difference between the intermediary transfer belt and the photosensitive drum to suppress the color misregistration.

Generally, an image forming apparatus is provided with a scanning optical portion for deflecting by a rotational mirror a laser beam ON-OFF modulated in accordance with scanning line image data as an expanded color separated image to expose the surface of the photosensitive drum having been electrically charged, by which an electrostatic latent image is written on the surface of the photosensitive drum. When the temperature in the main assembly of the apparatus increases, a lens and/or the rotational mirror or the like slightly deforms with the result of difficulty in exposing the correct position of the surface of the photosensitive drum. Under the circumstances, the exposure start timing is corrected on the basis of the pre-stored positional deviation amount between the different color images, so that the scanning equation optical portion projects the beam at the correct position on the surface of the photosensitive drum. In this specification, the period of the image formation means the period in which a toner image is formed on the photosensitive drum in accordance with the image information inputted from an outer terminal such as a scanner or a personal computer connected with the image forming apparatus. On the other hand, the period other than the image formation period is the period excluding the period of the image formation and includes the period of the interval between adjacent sheets during execution of the image formation job and the period in which no image forming operation is carried out.

However, in the conventional apparatus, the control for the registration correction and for the suppression of the production of the color misregistration (color misregistration suppression control) are started under the conditions which are independent from each other, and after that the color misregistration suppressing control, the registration correction is always carried out, with the result of a long down time of the apparatus. When the rotational speed of the photosensitive drum or the intermediary transfer belt is changed as a result of the above-described color misregistration suppressing control, the positions of the color images on the intermediary transfer belt change in a sub-scan direction, that is, the direction of the traveling of the intermediary transfer belt, with the result of production of the color misregistration. For the registration correction, the pre-stored positional deviation amount for each color is used, and therefore, when the color misregistration suppressing control is carried out, it is necessary to correct the pre-start positional deviation amount. Under the circumstances, a pattern image for the registration correction is formed on the intermediary transfer belt, and on the basis of the pattern image for the registration correction, the positional deviation amount is detected and stored for each color (so-called automatic registration) always with the execution of the color misregistration suppressing control.

On the other hand, the recent demand for the cost reduction and downsizing necessitates the downsizing of the driving roller and the intermediary transfer belt. When the diameter of the driving roller is reduced, the influence of the temperature is large, and therefore, the frequency of the execution of the color misregistration suppressing control increases. As described above, when the color misregistration suppressing control is carried out, the automatically registering operation always follows, and therefore, the increase of the frequency of the color misregistration suppressing control operations results in the increase of the down time of the image forming apparatus, and therefore, the operation of the apparatus is not efficient. If an attempt is made to simply reduce the frequency of the color misregistration suppressing control operation, the result is that color misregistration frequently occurs during the image formation.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, there is provided an image forming apparatus comprising a photosensitive drum; an exposure device configured to expose said photosensitive drum, having been charged, with image light to form an electrostatic image; a developing device configured to develop the electrostatic image into a toner image; an endless intermediary transfer belt stretched around a plurality of stretching rollers including a driving roller configured to apply a driving force to said intermediary transfer belt, said intermediary transfer belt temporarily carries the toner image having been primary-transferred from said photosensitive drum before secondary-transfer of the toner image onto a recording material; a first driving source for rotating said photosensitive drum; a second driving source for rotating said driving roller; a temperature detecting unit configured to detect a temperature of at least one of temperatures inside and outside of a main assembly of said apparatus; an optical detecting member configured to detect light applied to said intermediary transfer belt; an executing portion configured to execute an operation in an acquisition mode in which an adjusting toner image is formed on said intermediary transfer belt, the light is applied to the adjusting toner image and detected by said optical detecting member, and image exposure timing of said photosensitive drum is acquired on the basis of a detection result of said optical detecting member; and a determination portion configured to determine, when an image formation job is inputted, whether to execute a first image formation in which the operation in the acquisition mode is carried out, and an image forming operation is carried out using the exposure timing acquired by the operation in the acquisition mode or a second image formation in which the operation in the acquisition mode is not carried out, and the image forming operation is carried out using the exposure timing acquired by a previous acquisition mode operation, wherein said determination portion makes the determination on the basis of a result of current detection of said temperature detecting unit and a result of a detection of said temperature detecting unit in a previous first image formation, and wherein when said determination portion determines the execution of the first image formation, driving speeds of said first driving source and said second driving source are set, before the execution of the operation in the acquisition mode, on the basis of the result of the current detection of said temperature detecting unit, and the operations in the acquisition mode and the image formation are carried out using the driving speeds currently set.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of a general structure of an image forming apparatus according to an embodiment of the present invention.

FIG. **2** is a schematic view illustrating a structure of an image forming station.

FIG. **3** is a control block diagram of a control system for automatic registration.

FIG. **4** shows a pattern image for registration correction.

FIG. **5** is a flow chart of an image forming process for explaining the automatic registration in the first embodiment.

FIG. **6** is a flow chart showing the image forming process for explaining the automatic registration in a second embodiment.

DESCRIPTION OF THE EMBODIMENTS

Referring to the accompanying drawings, the embodiments of the present invention will be described in detail. Referring first to FIGS. **1** and **2**, the image forming apparatus will be described. FIG. **1** is a schematic view of the general arrangement of the image forming apparatus. FIG. **2** is a schematic view illustrating the structure of the image forming station. Image forming apparatus **100** shown in FIG. **1** is an intermediary transfer and tandem type color image forming apparatus in which four color image forming stations **81***a*, **81***b*, **81***c*, **81***d* are provided opposed to an intermediary transfer belt **87** in the main assembly of the apparatus.

<Image Forming Apparatus>

A recording material feeding process in the image forming apparatus **100** will be described. As shown in FIG. **1**, the recording material P (sheet of paper, OHP sheet or another sheet material) is accommodated in a sheet cassette **92** capable of being inserted into and pulled out of the main assembly A, in the form of a stack, and is fed out by a sheet feeding roller **93** in timed relation with the image formation. For the sheet feeding from the sheet cassette **92**, a friction separating type is usable, for example. The recording material P fed out by the sheet feeding roller **93** is fed to a couple of registration rollers along a feeding path. By the registration rollers **94**, the oblique feeding correction and the timing correction is carried out for the recording material P, and thereafter, the recording material P is supplied into the secondary transfer portion T**2**. The secondary transfer portion T**2** is constituted as a transfer nip provided by a driving roller **88** and an outer secondary-transfer roller **90** opposed to each other, and is effective to attract the toner image onto the recording material P by the applications of a predetermined pressure and an electrostatic bias voltage.

The description will be made as to an image forming process on the recording material P up to the secondary transfer portion T**2**. First, the image forming stations **81***a*-**81***d* will be described. The image forming stations **81***a*-**81***d* have substantially the same structures except that the colors of the toner used in developing portions **84***a*-**84***d* are different, that is, they are black, cyan, magenta and yellow. Therefore, in the following, the description will be made as to the image forming station **81***a*, and the description is applied to the image forming stations **81***b*, **81***c*, **81***d* by changing the suffix “a” to “b”, to “c” or to “d”, as the case may be.

As shown in FIG. **2**, in the image forming station **81***a*, a primary charger **83***a*, a scanning optical portion **50***a* as exposure means, a developing portion **84***a* and a drum cleaning portion **86***a* are provided. The photosensitive drum **82***a* includes a photosensitive layer at an outer peripheral surface thereof and is rotated in a direction indicated by an arrow R**1** at a predetermined process speed. The surface of the rotated photosensitive drum **82***a* is uniformly charged by the primary charger **83***a*, and is exposed to the beam by the scanning optical portion **50***a* operated in accordance with a signal indicative of the image information, so that an electrostatic latent image is formed. The scanning optical portion **50***a* deflects the laser beam ON-OFF modulated in accordance with the scanning line image data provided by expanding each color separated image by a rotational mirror to the exposed surface of the photosensitive drum **82***a* to form an electrostatic latent image.

The electrostatic latent image formed on the surface of the photosensitive drum **82***a* is visualized into a toner image by the developing portion **84***a* as the developing means. In other words, the developing portion **84***a* develops the electrostatic image into the toner image by supplying the toner onto the photosensitive drum **82***a*. In the developing portion **84***a*, a two component developer comprising toner (non-magnetic) having a negative charging property and carrier particles having a positive charging property is used, for example. Thereafter, the toner image formed on the photosensitive drum **82***a* is primary-transferred onto the intermediary transfer belt **87** by the applications of the predetermined pressure and the electrostatic bias voltage to the primary transfer roller **85***a* (FIG. **1**) opposed to the photosensitive drum **82***a* with the intermediary transfer belt **87** interposed therebetween. The drum cleaning portion **86***a* removes the primary-untransferred toner remaining on the photosensitive drum **82***a* after the primary-image transfer operation.

Referring back to FIG. **1**, the intermediary transfer belt **87** as the belt member is an endless belt rotationally traveling in contact with the photosensitive drum **82***a* in a direction indicated by an arrow R**2** in the Figure and is capable of receiving the toner image from the photosensitive drum **82***a*. The intermediary transfer belt **87** is an endless belt of resin material, and the inner surface thereof is contacted by a driving roller **88** and tension rollers **89** as support rotatable members. The intermediary transfer belt **87** is stretched by the driving roller **88** and the tension roller **89** at a predetermined tension. For example, to the tension roller **89**, a force is applied to the back side of the intermediary transfer belt **87** toward the front side by an elastic member (unshown) such as a spring, so that the intermediary transfer belt **87** is stretched at a predetermined tension. The intermediary transfer belt **87** rotates with the rotation of the driving roller **88** driven by the belt driving portion **112** (FIG. **3** which will be described hereinafter).

The image formation process for the respective colors by the image forming stations **81***d*-**81***a* are carried out at such a timing such that the toner image is overlaid sequentially on the upstream color (yellow, here) toner image already primary-transferred onto the intermediary transfer belt **87**. As a result, a multi-color (full-color) toner image is formed on the intermediary transfer belt **87** and is fed to the secondary transfer portion T**2**. By the above-described feeding process and image formation process, the secondary-transfer is carried out in the timed relation between the recording material P and the full-color toner image in the secondary transfer portion T**2**. The recording material P having been subjected to the secondary-transfer operation is fed into the fixing device **95**, where the toner image is fused and fixed on the recording material P by the predetermined pressure and heat quantity. The recording material P having been subjected to the image fixing operation is fed by the pair of feeding rollers **96** toward the sheet discharge tray **98** and is discharged onto the sheet discharge tray **98** by the rotation of the sheet discharging rollers **97**. Secondary-untransferred toner remaining on the intermediary transfer belt **87** after passing through the secondary transfer portion T**2** is removed by a belt cleaning portion **91**.

As shown in FIG. **1**, the image forming apparatus **100** comprises a temperature sensor **61**, an out-of-LS inside temperature sensor **62** and an in-LS inside temperature sensor **63**. The factors producing the color misregistration include a change of the apparatus outside temperature in the ambient condition in which the image forming apparatus **100** is placed, and in view of this, a temperature sensor **61** is provided. In addition, other factors include variations of the optical path resulting from variations of the optical portion members such as a lens or rotational mirror in the scanning optical portions **50***a*-**50***d* due to the temperature change in the scanning optical portions **50***a*-**50***d*, and in view of this, an in-LS inside temperature sensor **63** is provided. Further factors include temperature changes inside the main assembly A of the image forming apparatus **100**, which may influence the temperature in the scanning optical portion **50***a*-**50***d*, the intermediary transfer belt **87** and the photosensitive drums **82***a*-**82***d*, and in view of this, the out-of-LS inside temperature sensor **62** is provided.

The temperature sensor **61** as the first temperature detecting means is disposed at the position capable of detecting the temperature outside the main assembly of the image forming apparatus **100**, and detects the temperature outside the main assembly A (outside temperature). The out-of-LS inside temperature sensor **62** as the second temperature detecting means is disposed adjacent to the scanning optical portions **50***a*-**50***b*, the photosensitive drum **82***a*-**82***d* and the intermediary transfer belt **87** inside the main assembly of the image forming apparatus **100** to detect the temperature inside the main assembly (inside temperature). The in-LS inside temperature sensor **63** as the exposure temperature detecting means is disposed in a container of the scanning optical portion **50***d* to detect the temperature in the scanning optical portion **50***d* (in-LS temperature). The in-LS inside temperature sensor **63** may be provided for only one of the scanning optical portions **50***a*-**50***d*. For example, in the case that the reference color used to detect the color misregistration amount is yellow, it will suffice if the in-LS inside temperature sensor **63** is provided only in the container of the scanning optical portion **50***d* for the exposure for the yellow color.

In addition, the image forming apparatus **100** is provided with a registration sensor **71** as toner detecting means. The registration sensor **71** is provided at each of the front side and rear side positions (FIG. **1**) with respect to the direction perpendicular to the rotational direction of the intermediary transfer belt **87** and is effective to detect the toner image transferred onto the intermediary transfer belt **87**, and on the basis of the results of the detection, the positional deviation from the reference color position is corrected for each color. As will be described hereinafter, the registration sensor **71** detects the positional deviation amount from the yellow position, for example, which is the reference color, using a registration correction pattern for each color (FIG. **4** which will be described hereinafter) formed on the intermediary transfer belt **87**. In the image forming apparatus of this embodiment, the reference color for the detection of the positional deviation is yellow, because the image forming station **81***d* for the yellow color is less subjective to the influence of the heat such as dimension change of parts due to the thermal expansion, because it is farthest from the fixing device **95**.

<Controller>

The image forming apparatus **100** comprises a controller **101**. Referring to FIG. **3**, the controller **101** will be described. FIG. **3** is a control block diagram of a control system for an automatically registering operation. As shown in FIG. **3**, the temperature sensor **61**, the out-of-LS inside temperature sensor **62**, the in-LS inside temperature sensor **63**, the registration sensor **71**, the drum driving portion **111**, the belt driving portion **112** and the electric circuit substrate **14** are connected with the controller **101** through an interface (unshown).

The controller **101** as the executing means includes a CPU or the like, for example, for controlling the image forming apparatus **100**. The controller **101** includes memory **102** as the storing means. The controller **101** executes various software programs such as an image formation program stored in the memory **102**, and controls the image forming apparatus **100** with the execution of the program. The memory **102** is used as a workspace for the calculation process required to store the various software programs, to temporarily store the control data, or the like. For example, the controller **101** carries out the various controls for the image formation by the image forming stations **81***a*-**81***d*, and for the recording material P feeding and so on. In addition, the controller **101** acquires at the proper timing the number of total prints counted during the image forming operation, the result of detections of the temperature sensor **61**, the out-of-LS inside temperature sensor **62** at the in-LS inside temperature sensor **63**, and the results of detection of the registration sensor **71**, and the controller **101** stores them in the memory **102**.

The drum driving portion **111** as the first driving means rotates the photosensitive drums **82***a*-**82***d*, and the belt driving portion **112** as the second driving means rotates the intermediary transfer belt **87**. The controller **101** controls the drum driving portion **111** in the form of a motor or the like and the belt driving portion **112**, and is capable of changing the rotational speeds thereof so that the peripheral speed difference between the intermediary transfer belt **87** and the photosensitive drums **82***a*-**82***d* is within a predetermined range. The electric circuit substrate **14** includes a laser driving circuit for generating a laser beam to be projected from the scanning optical portion **50**, and a mirror driving circuit for deflecting the rotational mirror. The controller **101** controls the electric circuit substrate **14** to write an electrostatic latent image on the surfaces of the photosensitive drums **82***a*-**82***d* with the laser beam deflected by the rotational mirror.

The controller **101** is capable of executing the automatically registering operation in which the positional deviation amount for each color to be used for the registration correction is stored in the memory **102**. In this embodiment, the automatically registering operation can be carried out at proper execution timing. When the automatic registration is carried out, registration correction pattern images are formed on the intermediary transfer belt **87**. In order to form the registration correction pattern image, the laser irradiation by the scanning optical portion **50** is carried out to form the electrostatic latent image as the registration correction pattern on each of the photosensitive drums **82***a*-**82***d*. Then, the electrostatic latent images are developed with the toner particles of the respective colors by the developing portions **84***a*-**84***d*, so that toner images of the registration correction patterns of the respective colors are formed on the photosensitive drums **82***a*-**82***d*, respectively. The toner images formed on the photosensitive drums **82***a*-**82***d* are transferred onto the intermediary transfer belt **87** in the primary transfer portion T**1** (FIG. **1**).

FIG. **4** shows an example of the registration correction pattern image formed on the intermediary transfer belt **87**. As shown in FIG. **4**, a plurality of the registration correction pattern images are formed continuously along the rotational moving direction on the intermediary transfer belt **87**. The registration correction pattern images for yellow, magenta, cyan and black colors are formed in the order named from the downstream with respect to the rotational moving direction of the intermediary transfer belt **87** on the upper side (**712**Y-**712**K) and the lower side (**711**Y-**711**K) in FIG. **4** in two rows.

First Embodiment

Referring to FIG. **5**, the automatic registration in the first embodiment of the present invention will be described. FIG. **5** is a flow chart showing the image forming process operation for explaining the automatically registering operation in the first embodiment. The image forming process shown in FIG. **5** starts with the input of the image formation job and ends with the completion of the image formation job. Here, the image formation job is a series of operations from a start of preliminary operation (pre-rotation) required for the image forming operation in response to a printing instruction signal to a post operation (post-rotation) required for finishing the image forming operation after the execution of the image forming process. More particularly, it means the operations from the pre-rotation (preparing operations before the execution of the image forming operation) after the production of the printing instruction signal (input of the image formation job) to the post-rotation (operations after the execution of the image formation), and it includes the period of the image formation and the period between adjacent recording materials.

As shown in FIG. **5**, the controller **101** discriminates whether or not a temperature change (ΔT**61**) of the apparatus outside is larger than 4 degrees on the basis of the results of the detection of the temperature sensor **61** (S**1**). If the temperature change (ΔT**61**) is discriminated as being not more than 4 degrees (NO in step S**1**), the controller **101** discriminates whether or not the temperature change (ΔT**62**) of the temperature inside of the apparatus is higher than 3 degrees on the basis of the results of the detection of the out-of-LS inside temperature sensor **62** (S**2**). If the temperature change (ΔT**62**) is discriminated as being not more than 3 degrees (NO in step S**2**), the controller **101** discriminates whether or not a temperature change (ΔT**63**) of the in-LS temperature is larger than 3 degrees on the basis of the results of the detection of the in-LS inside temperature sensor **63** (S**3**). If the temperature change (ΔT**63**) is discriminated as being not more than 3 degrees (NO in step S**3**), the controller **101** does not carry out the processings S**4**-S**6** and jumps to the processing of step S**7**. The temperature changes are determined on the basis of the comparison with the corresponding temperatures detected by the temperature sensor **61**, the out-of-LS inside temperature sensor **62** and the in-LS inside temperature sensor **63** in the execution of the previous automatically registering operation (correction mode). The apparatus outside temperature, the apparatus inside temperature and the in-LS temperature detected in the previous automatically registering operation are stored in the memory **102**.

The controller **101** carries out the color misregistration suppressing control and the automatically registering operation, if the result of either one of the detections in the steps S**1**-S**3** is affirmative. More particularly, the color misregistration suppressing control and the automatically registering operation are carried out when the apparatus outside temperature change (ΔT**61**) is larger than 4 degrees, when the apparatus inside temperature change (ΔT**62**) is larger than 3 degrees, or in-LS temperature change (ΔT**63**) is larger than 3 degrees. These threshold levels of the temperature changes are merely examples, and the present invention is not limited to these examples. The threshold (4 degrees) for the apparatus outside temperature change (ΔT**61**) is higher than the threshold (3 degrees) for the apparatus inside temperature change ((ΔT**62**)), because the apparatus inside temperature change is more influential to the color misregistration than the apparatus outside temperature change.

The controller **101** executes the color misregistration suppressing control as the rotation control mode when either one of the results of detections in the steps S**1**-S**3** is affirmative (S**4**). That is, the drum driving portion **111** is controlled to change the rotational speeds of the photosensitive drums **82***a*-**82***d*. At this time, the controller **101** determines the difference between the apparatus inside temperature (T**62**) and a predetermined reference temperature (T**62**ref), and controls the rotational speed of the drum driving portion **111** on the basis of the thus determined difference. For example, the rotational speed of the drum driving portion **111** is determined on the basis of the change of the relative speed calculated by the following:

$$(T62-T62\mathrm{ref})\times 0.004\% \qquad (1)$$

A specific example will be described. It is assumed that the rotational speed of the drum driving portion **111** is 2056.98 (rpm) under the reference temperature. In this case, if the apparatus inside temperature (T**62**) is higher than the reference temperature by approx. 4 degrees, the rotational speed of the drum driving portion **111** is increased by 0.016%, that is, to 2057.31 (rpm). By controlling the drum driving portion **111** in this manner, the peripheral speed difference between the photosensitive drums **82***a*-**82***d* and the intermediary transfer belt **87** is corrected, so that the color misregistration is suppressed. Thereafter, the controller **101** proceeds to the processing of step S**5**.

The controller **101** carries out the automatically registering operation as the correction mode through steps **S5** and **S6** which will be described below. The controller **101** executes the automatically registering operation (S**5**). In the automatically registering operation, the registration correction pattern image for each color shown in FIG. **4** is formed on the intermediary transfer belt **87**. Then, the controller **101** detects the thus formed registration correction pattern by the registration sensor **71** to detect a positional deviation amount for each color from the reference color (yellow) position, and stores the amount in the memory **102** (S**6**). At this time, the apparatus outside temperature, the apparatus inside temperature and the in-LS temperatures are also stored in the memory **102**. The controller **101** executes the process of the steps **S1**-**S6** during the pre-rotation period other than the image formation period.

When the pre-rotation is completed, the controller **101** carries out the various processing for the image formation (S**7**-S**11**). In the image forming process, the controller **101** carries out the sheet feeding in which the recording material P is singled out from the sheet cassette **92** by the sheet feeding roller **93** (S**7**). Then, the controller **101** executes the image forming operation (S**8**). Here, the electrostatic latent images are formed on the surface of the photosensitive drums **82***a*-**82***d*, and the electrostatic latent images are visualized by development with toner using the developing portions **84***a*-**84***d*. The toner images formed on the photosensitive drums **82***a*-**82***d* are primary-transferred onto the intermediary transfer belt **87**, and the toner image transferred onto the intermediary transfer belt **87** is secondary-transferred onto the recording material P.

When the electrostatic latent images are formed on the surface of the photosensitive drums **82***a*-**82***d*, the controller **101** effects the registration correction on the basis of the positional deviation amount for each color which has been stored in the memory **102** by the execution of the automatically registering operation (S**5** and S**6**). Here, referring to FIG. **4**, the automatically registering operation will be described using the registration correction pattern image (registration patch image) shown in this Figure.

The image position detection on the intermediary transfer belt **87** is carried out by sequentially reading the registration patch images (**711**Y-**711**K, **712**Y-**712**K) of the respective colors by two registration sensors (**71**R, **71**F) provided at the upper side in FIG. **4** (rear side in FIG. **1**) and at the lower side in FIG. **4** (front side in FIG. **1**). That is, the time periods in which the registration patch images pass the registration sensors (**71**R, **71**F) are counted, so that the relative positional relation between the registration patch images are determined. For example, in FIG. **4**, when the lower side registration patch images **711**Y-**711**K pass the lower side registration sensor (**71**F) at the position indicated by the chain line N, the time periods required for the registration patch images **711**Y-**711**K to pass ranges Y1F, M1F, C1F and K1F are determined. By the lengths of the required time periods, the positional deviation amounts of the writing start position in the main scanning direction are detected. For example, when the length is longer than the predetermined length, the writing start position in the main scanning direction is deviated toward the lower side in FIG. **4**, and on the other hand, when the length is shorter than the predetermined length, the writing start position is deviated toward the upper side in FIG. **4**.

In FIG. **4**, when the upper side registration patch images **712**Y-**712**K pass the upper side registration sensor (**71**R) at the position indicated by the chain line M, the time periods required for the registration patch images **712**Y-**712**K to pass the ranges Y1R, M1R, C1R and K1R are determined. The lengths of the periods are compared with the length acquired from the ranges Y1F, M1F, C1F and K1F by the registration sensor (**71**F), by which the deviation amount of the total magnification in the main-scanning can be detected. For example, if the length for passing the Y1R is longer than that for passing the Y1F, the interval between the registration patch image **711**Y and the registration patch image **712**Y is short, and therefore, the total magnification of the yellow image is small in the main scanning direction. On the other hand, if the length for passing the Y1R is shorter than that for passing the Y1F, the interval between the registration patch image **711**Y and the registration patch image **712**Y is long, and therefore, the total magnification of the yellow image is large in the main scanning direction. The same detecting operations are carried out for the other colors, namely, magenta, cyan and black images.

On the other hand, with respect to the sub-scan direction, in FIG. **4**, when the lower side registration patch images **711**Y-**711**K pass the lower side registration sensor (**71**F) at the position indicated by chain line N, the widths of the ranges Y1F, M1F, C1F and K1F of the registration patch images **711**Y-**712**K are detected. Then, the centers of the widths are determined, and the distances between the registration patch image **711**Y and the registration patch images **711**M, **711**C, **711**K (YM, YC, YK in the Figure) are calculated, and the data from one full circumference of the intermediary transfer belt **87** are stored in the memory **102**.

In the case of the registration correction with respect to the sub-scan direction, that is, with respect to the rotational moving direction of the intermediary transfer belt **87**, the registration correction is executed between the registration patch image **711**Y and the registration patch image **711**M (YM in the Figure) on the basis of the average of all the data of the distance YM stored in the memory **102**. In addition, the registration correction is executed between the registration patch image **711**Y and the registration patch image **711**C (YC in the Figure) on the basis of the average of all the data of the distance YC stored in the memory **102**. In addition, the registration correction is executed between the registration patch image **711**Y and the registration patch image **711**K (YK in the Figure) on the basis of the average of all the data of the distance YK stored in the memory **102**. Thus, by the registration correction, the exposure start timing for the photosensitive drums **82***a*-**82***d* by the scanning optical portions **50***a*-**50***d* is corrected on the basis of the positional deviation amounts for the respective colors stored in the memory **102** so that the laser beams are projected to the correct positions on the surface of the respective photosensitive drums **82***a*-**82***d*.

Referring back to FIG. **5**, the controller **101** fixes the toner image on the recording material P by the fixing device **95** (S**9**), and the recording material P is discharged onto the sheet discharge tray **98**. The controller **101** discriminates whether or not the final page has been printed. If not (NO of step S11), the operation returns to the step S7, and the operations of steps S7-S11 are repeated to form images on the recording materials P. If it is discriminated that the final page has been printed (YES in the step S11), the controller **101** executes the post-rotation and completes the image forming process operation.

As described in the foregoing, in the image forming apparatus **100**, the automatic registration is carried out when one of the apparatus outside temperature change, the apparatus inside temperature change and the in-LS temperature change is larger than the threshold. And, the color misregistration suppressing control is started only at the execution timing for the automatic registration. However, because the drum driving portion **111** is controlled by the rotational speed determined by the apparatus inside temperature (equation (1)), the color misregistration suppressing control is substantially carried out when the apparatus inside temperature changes. That is, the execution of the automatic registration is not executed at all times with the execution of the color misregistration suppressing control, but only when the automatic registration is carried out, the necessity for the color misregistration suppressing control is substantially discriminated before the execution of the automatic registration. This is because it is not always inevitable to execute the color misregistration suppressing control when the automatic registration is executed, but depending on the situation, the color misregistration suppressing control is executed before the execution of the automatic registration, by which the positional deviation amounts for the respective colors can be more correctly detected than when the color misregistration suppressing control is not executed. In addition, even if the color misregistration suppressing control is executed before the execution of the automatic registration, the down time of the image forming apparatus **100** does not increase as compared with the case in which only the automatic registration is carried out.

Thus, the color misregistration suppressing control and the automatic registration are not carried out frequently, and as a result, the down time of the image forming apparatus **100** does not increase, and therefore, the image forming apparatus **100** is efficiently operated. The out-of-LS inside temperature sensor **62** functions as the temperature sensor to be used to determine the execution timing of the automatic registration and also as the temperature sensor to be used to substantially determine the necessity for the color misregistration suppressing control. By using the same sensor (out-of-LS inside temperature sensor **62**), both of the automatic registration and the color misregistration suppressing control can be carried out without increasing the number of the temperature sensors, and therefore, the cost reduction, the downsizing and the energy saving can be accomplished.

Second Embodiment

Referring to FIG. **6**, the automatic registration in a second embodiment of the present invention will be described. FIG. **6** is a flow chart showing the image forming process for explaining the automatic registration in the second embodiment. The image forming process in FIG. **6** is the same as that of the foregoing embodiment (FIG. **5**) except that the step S**21** is added between the steps S**3** and S**4**. Therefore, in the following, the process of the step S**21** will mainly be described.

The controller **101** discriminates (S**21**) whether to execute the color misregistration suppressing control (the control for the drum driving portion **111**, here), when any one of the results of steps S**1**-S**3** is YES. When the color misregistration suppressing control is discriminated as being not necessary (NO in step S**21**), the controller **101** executes the automatically registering operation (S**5**) without carrying out the control for the drum driving portion **111** (S**4**). On the other hand, when the color misregistration suppressing control is discriminated as being to be carried out (YES in S**21**), the controller **101** executes the control for the drum driving portion **111** (S**4**), and then executes the automatically registering operation (S**5**).

When the color misregistration suppressing control is carried out, the controller **101** determines the average of the apparatus outside temperature (T**61**) detected by the temperature sensor **61** and the out-of-LS inside temperature detected by the out-of-LS inside temperature sensor **62**, and on the basis of the average, the rotational speed of the drum driving portion **111** is controlled. For example, the rotational speed of the drum driving portion **111** is determined on the basis of the relative speed change determined by the equations (2) and (3).

$$\text{When } (T61+T62)/2>30,\ +0.05\% \tag{2}$$

$$\text{When } (T61+T62)/2<7.5,\ -0.05\% \tag{3}$$

Specific examples will be described. It is assumed that the rotational speed of the drum driving portion **111** is 2056.98 (rpm) under the reference temperature. In this case, if the average of the apparatus outside temperature and the out-of-LS inside temperature is higher than 30 degrees, the rotational speed of the drum driving portion **111** is increased by 0.05% up to 2058.01 (rpm). On the other hand, if the average of the apparatus outside temperature and the out-of-LS inside temperature is lower than 7.5 degrees, the rotational speed of the drum driving portion **111** is decreased by 0.05% down to 2055.95 (rpm). By controlling the drum driving portion **111** in this manner, the peripheral speed difference between the photosensitive drums **82***a*-**82***d* and the intermediary transfer belt **87** is corrected, so that the color misregistration is suppressed. Thereafter, the controller **101** proceeds to the processing of step S**5**. When the average of the apparatus outside temperature and the in-LS temperature is in the range of 7.5-30 degrees, the control for the drum driving portion **111** is not carried out.

According to this embodiment, the same advantageous effects as in the first embodiment can be provided. That is, the color misregistration suppressing control is carried out only at the timing of the execution of the automatic registration, and therefore, the color misregistration suppressing control and the automatic registration are not carried out frequently. If the printing operation is carried out after the image forming apparatus **100** is kept unoperated under the low temperature ambient condition, the apparatus inside temperature may steeply increase. In such a case, the influence of the steep temperature change inside the apparatus can be reduced by using the temperature sensor **61**. On the other hand, by using the out-of-LS inside temperature sensor **62** similarly to the first embodiment, the influence of the steep temperature change in the installation place of the image forming apparatus **100** by the air conditioner or the like is reduced. In addition, by the control for the drum driving portion **111** using two sensors (temperature sensor **61** and out-of-LS inside temperature sensor **62**), the influence of the sensor errors is less than in the case of the first embodiment in which the control for the drum driving portion **111** is carried out only by out-of-LS inside temperature sensor **62**. From the foregoing, as compared with the first embodiment, the further stabilized control is accomplished for the drum driving portion **111**. In addition, it is unnecessary to increase the number of the temperature sensors, so the cost is low, and the downsizing and the energy saving are accomplished.

The Other Embodiments

The above-described color misregistration suppressing control and the automatic registration may be made possible to be carried out after temporary interruption of the image forming operation for the plurality of continuous image formations. In the foregoing, the correction of the peripheral speed difference between the intermediary transfer belt **87** and the photosensitive drums **82***a*-**82***d* is carried out by controlling the drum driving portion **111**, but it may be carried out by controlling the belt driving portion **112**. More particularly, the peripheral speed difference may be corrected by changing the rotational speed of the intermediary transfer belt **87** not the rotational speeds of the photosensitive drums **82***a*-**82***d*. When the rotational speed of the intermediary transfer belt **87** changes, a speed difference may result between the recording material P and the intermediary transfer belt **87** in the feeding along the feeding path. Therefore, the change of the rotational speeds of the photosensitive drums **82***a*-**82***d* by controlling the drum driving portion **111** is preferable.

In the above-described second embodiment, the necessity for the control of the drum driving portion **111** is discriminated on the basis of the average of the apparatus outside temperature and the out-of-LS inside temperature, but it is possible that one of them is weighted. Further alternatively, the in-LS inside temperature alone may be used. Particularly when the in-LS inside temperature is weighted, the temperature in the scanning optical portion **50***d* is reflected on the control, and therefore, the peripheral speed difference between the intermediary transfer belt **87** and the photosensitive drums **82***a*-**82***d* can be more precisely controlled.

The present invention is applicable to a tandem type, a single drum type, an intermediary transfer type, a recording material feeding type and so on, if the toner images of respective colors are superimposed in the image transfer operation. In the foregoing embodiments, the major parts relating to the formation and transfer of the toner image have been described, but the present invention is usable in various printing machines, copying machines, facsimile machines, multifunction machines or the like with necessary parts and means added.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Applications Nos. 2015-009328 filed on Jan. 21, 2015 and 2015-211877 filed on Oct. 28, 2015, which are hereby incorporated by reference herein in their entirety.

What is claimed is:

1. An image forming apparatus comprising:

a photosensitive drum;

an exposure device configured to expose said photosensitive drum, having been charged, with image light to form an electrostatic image;

a developing device configured to develop the electrostatic image into a toner image;

an endless intermediary transfer belt stretched around a plurality of stretching rollers including a driving roller configured to apply a driving force to said intermediary transfer belt, said intermediary transfer belt temporarily carrying the toner image having been primary-transferred from said photosensitive drum before secondary-transfer of the toner image onto a recording material;

a first driving source for rotating said photosensitive drum;

a second driving source for rotating said driving roller;

a temperature detecting unit configured to detect a temperature of at least one of temperatures inside and outside of a main assembly of said apparatus;

an optical detecting member configured to detect light applied to said intermediary transfer belt;

an executing portion configured to execute an operation in an acquisition mode in which an adjusting toner image is formed on said intermediary transfer belt, the light is applied to the adjusting toner image and detected by said optical detecting member, and image exposure timing of said photosensitive drum is acquired on the basis of a detection result of said optical detecting member; and

a determination portion configured to determine, when an image formation job is inputted, whether to execute a first image formation in which the operation in the acquisition mode is carried out, and an image forming operation is carried out using the exposure timing acquired by the operation in the acquisition mode or a second image formation in which the operation in the acquisition mode is not carried out, and the image forming operation is carried out using the exposure timing acquired by a previous acquisition mode operation, wherein said determination portion makes the determination on the basis of a result of a current detection of said temperature detecting unit and a result of a detection of said temperature detecting unit in a previous first image formation, and wherein when said determination portion determines the execution of the first image formation, driving speeds of said first driving source and said second driving source are set, before the execution of the operation in the acquisition mode, on the basis of the result of the current detection of said temperature detecting unit, and the operation in the acquisition mode and the image formation are carried out using the driving speeds currently set.

2. An apparatus according to claim **1**, wherein said temperature detecting unit includes a plurality of temperature detecting members including a first temperature detecting member configured to detect the temperature outside of the main assembly and a second temperature detecting member configured to detect the temperature inside of the main assembly, wherein said determination portion determines, for at least one of said first temperature detecting member and said second temperature detecting member, a difference between the result of the current detection of the temperature detecting member and the result of the detection of the temperature detecting member in the previous first image formation, and wherein said determination portion determines the execution of the first image formation when an absolute value of the difference exceeds a threshold predetermined for each of the temperature detecting members.

3. An apparatus according to claim **2**, wherein said determination portion determines the execution of the second image formation when the absolute values for both of said first temperature detecting member and second temperature detecting member are not more than the thresholds predetermined for said first temperature detecting member and said second temperature detecting member, respectively.

4. An apparatus according to claim **2**, wherein when said determination portion determines the execution of the first image formation, the current driving speeds are set on the basis of an average of the results of the current detections of said first temperature detecting member and said second temperature detecting member and on the basis of the previously set driving speeds of said first driving source and said second driving source.

5. An apparatus according to claim **4**, wherein when the average is not more than a predetermined upper limit value and not less than a predetermined lower limit value, said determination portion sets the current driving speeds of said first driving source and said second driving source at the previously set driving speeds.

6. An apparatus according to claim **4**, wherein when the average is larger than a predetermined upper limit value or smaller than a predetermined lower limit value, said determining portion sets the current driving speed of one of the driving speeds of said first driving source and said second driving source to a driving speed different from the previously set driving speed.

7. An apparatus according to claim **4**, wherein said temperature detecting unit is the exposed inside a container containing said exposure device and includes a third temperature detecting member configured to detect a temperature inside said container.

8. An image forming apparatus according to claim **2**, wherein the threshold predetermined for said first temperature detecting member is higher than the threshold predetermined for said second temperature detecting member.

9. An apparatus according to claim **1**, wherein when said determination portion determines the execution of the second image formation, the image forming operation is carried out using the previously set driving speeds of said first driving source and said second driving source and the exposure timing acquired in the previous acquisition mode.

10. An apparatus according to claim **1**, wherein a plurality of said photosensitive drums are provided along said intermediary transfer belt, and a plurality of said exposure devices are provided for the respective photosensitive drums, wherein said executing portion forms an adjusting toner image on said intermediary transfer belt for each of said photosensitive drums and executes the operation in the acquisition mode to acquire the exposure timing for each of said photosensitive drums using the detection result of said optical detecting member from the corresponding adjusting toner image.

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